SEASONAL ABUNDANCE OF SMALL SIZED JUVENILE *RASTRELLIGER KANAGURTA* AT VIZHINGAM DURING 1960-1963

By P. Sam Bennet

(*Central Marine Fisheries Research Institute*)

The Indian mackerel, *Rastrelliger kanagurta* (Cuvier) occur in good numbers along the east and west coast of India and is one of the most important commercial fishes in Indian waters. Much of the research was done on the west coast, where there is a considerable fishery for the mackerel. As in most pelagic fishes there have been tremendous variations in yield. Catch in one area of the coast has often differed markedly from that in other areas in the same season, and periods of abundance have been followed by periods of scarcity. This report presents a comprehensive picture of the seasonal abundance and general biology of small sized juvenile mackerel based on observations made at Vizhingam, the southern most centre in the 'mackerel zone' of the west coast of India during 1960-63. The study serves as a basis for fixing the spawning season and spawning periodicity of the Indian mackerel. Appearance of shoals of juvenile mackerel in the inshore fishing grounds is discussed in relation to the prevailing water temperature. Quantitative data on seasonal abundance of juveniles may help in understanding the success or failure of particular year classes and thus in finding reasons for fluctuations in abundance and in developing ways to control the fluctuations. Fishable stocks of mackerel during certain years have become depleted by the fishery to a point where the annual production is well below what it could be, had the small sized juveniles been allowed to grow. An attempt is made to evaluate the detrimental effect of large scale fishing of small sized juveniles when they enter into the fishing grounds. Brief observations on older fish sampled throughout the year are also included.

Material and Methods

Samples on which this study is based were collected from Vizhingam Bay between July 1960 and July 1963 from commercial landings. Fishing for mackerel was almost restricted to a belt of five miles from shore. Normally mackerel was caught by boat seines and shore seines. Between October and December large sized mackerel were caught by drift nets. A few hand lines were also operated during this period to catch mackerel. A detailed account of the craft and gear operating at Vizhingam is given by Nayar (1958). Information on amounts of fish caught by various gears was gathered by random

sampling of the catch on the spot. Length measurements were made in millimetres using a standard measuring board. Total length, from tip of the upper jaw to tip of the longest caudal lobe was taken as the linear measurement. Weights were recorded in grammes.

AVAILABILITY

The Indian mackerel is a pelagic shoaling fish and appears to form large compact shoals. Pradhan and Rao (1958) state that the mackerel fishery in the southern region from Ponnani river to Cape Comorin is poor or moderate and the catches are obtained at irregular intervals during the months of August to February. Panikkar (1952) in reviewing the fisheries research in India states that the mackerel appear earlier in the south and slowly extend northwards. Later Sekharan (1958) discussing the South Kanara coastal fishery for mackerel reports 'in effect, there appears to be a rather sudden rise followed by an equally sudden fall in the abundance of the exploitable stock in the coastal waters during the main part of the season'. A brief account about the world distribution of the Indian mackerel is given by Jones and Silas (1962). Rao (1962) gives a consolidated account of the distribution of young stages of the mackerel in the Indian inshore waters.

From the shore-seine and boat seine catches observed at Vizhingam, it seems, that the Indian mackerel tends to form large compact shoals which at times move as close as 1 km. to the shore. In mid-July 1963 one boat seine landed as much as 1,225 kg. of juvenile mackerel at Vizhingam. That larger fish also show similar trend in their movements is seen from the shore seine catches of Malabar and Kanara coasts (Pradhan 1956, Sekharan 1958). Drift net catches of mackerel are little. Seine net operations are much more productive. Monthly yield of the fishery average 3,062 kg., the greatest monthly production occurred in July 1963 when 38,167 kg. (more than ten times the monthly average) consisting of juveniles were reported for the area. July 1960 with a landing of 12,071 kg. was the second best period.

Landings by commercial units fluctuated markedly during 1960 to 1963. From July 1960 to June 1961 the catch was 44,379 kg. Total catch for the 1961-62 season was 18,277 kg. The 1962-63 season showed slight improvement from the 1961-62 season. Estimated catch for the period from July 1962 to June 1963 was 20,416 kg. For July 1963 the catch was 38,167 kg. Tables 1-3 give monthly summary of the commercial landings. It is seen that the month July was the best season for mackerel fishery at Vizhingam. Juvenile mackerel appear in greater catchable concentration in July and are caught in large numbers by boat seines not for off from shore.

Age and Length Composition

Regular samples were analysed from commercial landings for age and length composition. Length measurements were made in millimetres and grouped into 0.5 cm. intervals. During certain months when the fishery was poor or the fishing was during the night all available material were used for length frequency observations. Complete accuracy cannot be claimed for figures relating to age groups. Because of intermittant appearance of young fish it has become impossible to determine the age groups through length frequency analysis. In many cases it has been necessary to use best approximations in place of clear cut facts, taking into consideration the views of earlier workers (Pradhan 1956 and Sekharan 1958) in this subject. Mackerel attains a length of 12-15 cm. in one year and 21-23 cm. in two years. Fish above 23 cm. are considered as in the third year of growth. A total of 3,240 fish in 1960-61, 1,873 fish in 1961-62, 1,499 fish in 1962-63 and 253 fish in July of 1963-64 seasons were measured for age and length analysis. Fish in the age range of 0 to 2 years and length range of 3.5 to 28.0 cm. were encountered during the course of this study.

In the 1960-61 season, of the total landing of 8,57,346 fish 46.6% was composed of 0-year group, 49.4% of 1-year group and 4.0% fish in the 2-year group. During the 1961-62 fishing season an estimated number of 17,25,818 mackerel were landed by the commercial fishermen. Of this 96.3% was formed of 0-year group, 3.6% in the 1-year group and 0.1% in the 2-year group. Very large number of fish in 1961-62 season was formed of 0-year group juveniles. The 1962-63 season witnessed almost a similar trend like that of the 1961-62 season. Landings totalled 24,58,963 fish, of which 95.6% were in the 0-year group, 4.3% in the one year group and 0.1% in the 2-year group. In the 1963-64 season only the month of July is included in this study. During the month 27,79,577 mackerel were landed. Of these 95.6% belonged to 0-year group and 4.4% belonged to 1-year group. There were no landings of fish in the 2-year group.

The 0-year group dominated the mackerel fishery during the period except the 1960-61 season. On the whole this group of young juveniles contributed over two-thirds of the total number of mackerel landed during July 1960 to July 1963. One year group comes next and the contribution of the 2-year group in numbers is almost negligible. One year group was slightly more numerous in the 1960-61 season than the 0-year group. Predominance of the older fish in this season accounted for the greater weight of fish landed than the next two seasons although number of mackerel landed in the two subsequent seasons are more than the 1960-61 season.

TABLE I

Age composition of the mackerel catch at Vizhingam, 1960-61 *season*

Months	Catch		Number of fish by age groups		
	Kg.	Numbers	0-year	1-year	2-year
July 1960 . . .	12,071	4,19,543	3,22,061	97,482	00
August . . .	4,591	81,593	15,955	65,638	00
September . .	11,617	1,63,214	9,890	1,53,324	00
October . . .	3,107	37,472	222	37,250	00
November . .	925	21,611	14,982	4,726	1,903
December . . .	1,745	41,702	28,727	9,268	3,707
January 1961 .	4,616	37,074	00	24,513	12,561
February . . .	1,129	6,876	00	00	6,876
March . . .	1,349	7,322	00	00	7,322
April . . .	2,716	21,779	00	21,779	00
May . . .	321	14,369	6,891	6,089	1,389
June . . .	192	4,790	1,197	3,593	00
TOTAL . . .	44,379	85,73,46	3,99,925	4,23,662	33,758
Per cent. . .		100%	46.646%	49.416%	3.938%

TABLE II

Age composition of the mackerel catch at Vizhingam, 1961-62 season

Months	Catch		Number of fish by age groups		
	Kg.	Number	0-year	1-year	2-year
July 1961 . . .	2,893	5,13,182	5,13,182	00	00
August . . .	557	76,032	76,032	00	00
September . .	1,234	34,624	27,221	7,403	00
October . . .	2,300	17,975	00	17,975	00
November . .	2,610	3,86,173	3,86,173	00	00
December . . .	435	5,439	2,418	2,064	957
January 1962 . .	20	148	00	121	27
February . . .	50	60,724	60,724	00	00
March . . .	15	104	00	52	52
April . . .	621	13,131	00	13,131	00
May . . .	278	2100	00	1,750	350
June . . .	7,264	6,16,186	5,95,797	20,389	00
TOTAL .	18,277	1,7,25,818	166,15,47	62,885	1,386
Per cent . . .		100%	96.275%	3.643%	0.082%

TABLE III

Age composition of the mackerel catch at Vizhingam 1962-63 season

Months	Catch		Number of fish by age group		
	Kg.	Numbers	0-year	1-year	2-year
July 1962 . . .	8,084	2,136,218	21,23,762	12,456	00
August . . .	6,355	1,92,526	1,54,679	37,847	00
September . .	522	14,813	10,638	4,175	00
October . . .	3,411	42,623	395	42,228	00
November . .	00	00	00	00	00
December . . .	326	4,076	1,812	1,548	716
January 1963 . .	235	2,023	00	1,626	397
February . . .	50	306	00	35	271
March . . .	260	1,439	00	26	1,413
April . . .	95	763	00	690	73
May . . .	160	3,777	3,136	218	363
June . . .	918	60,399	56,406	3,993	00
TOTAL .	20,416	24,58,963	23,50,828	1,04,842	3,233
Per cent . . .	..	100%	95.602%	4.263%	0.131%
July 1963 . . .	38,167	27,79,577	26,58,726	1,20,851	00
Per cent . . .		100%	95.652%	4.348%	

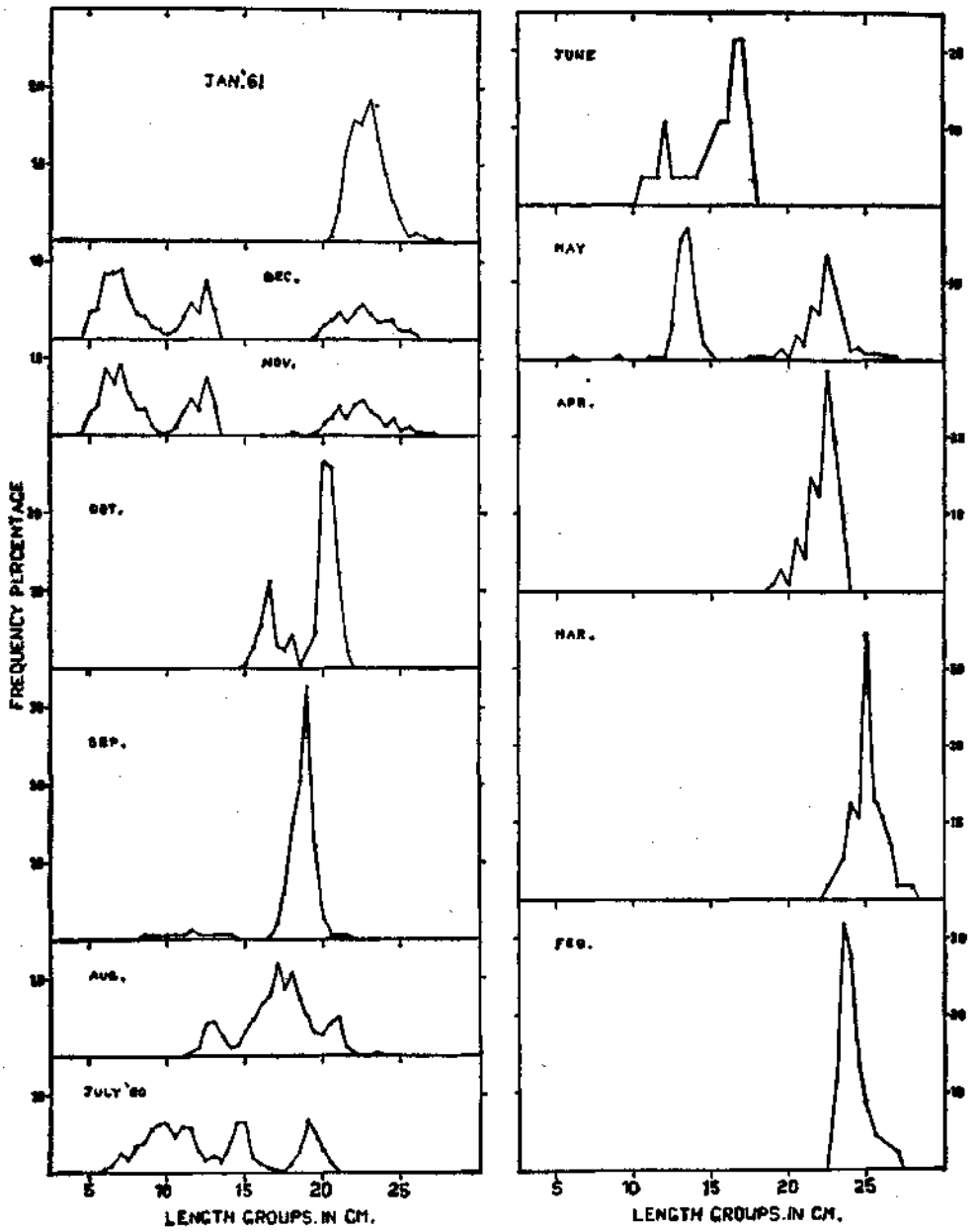

FIG. 1 Percentage length composition of the 1960-61 commercial mackerel catch at Vishingam

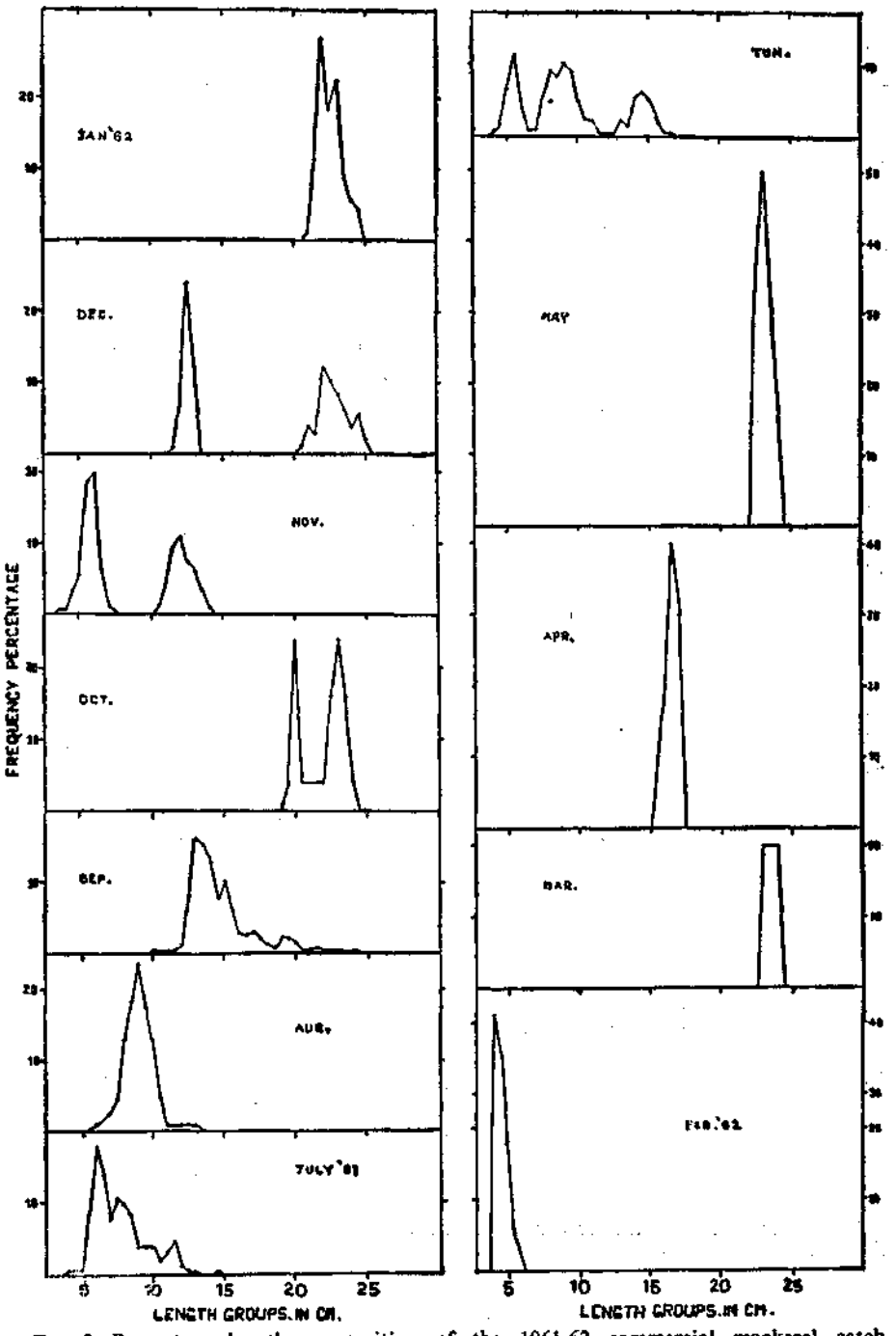

FIG. 2 Percentage length composition of the 1961-62 commercial mackerel catch at Vizhingam.

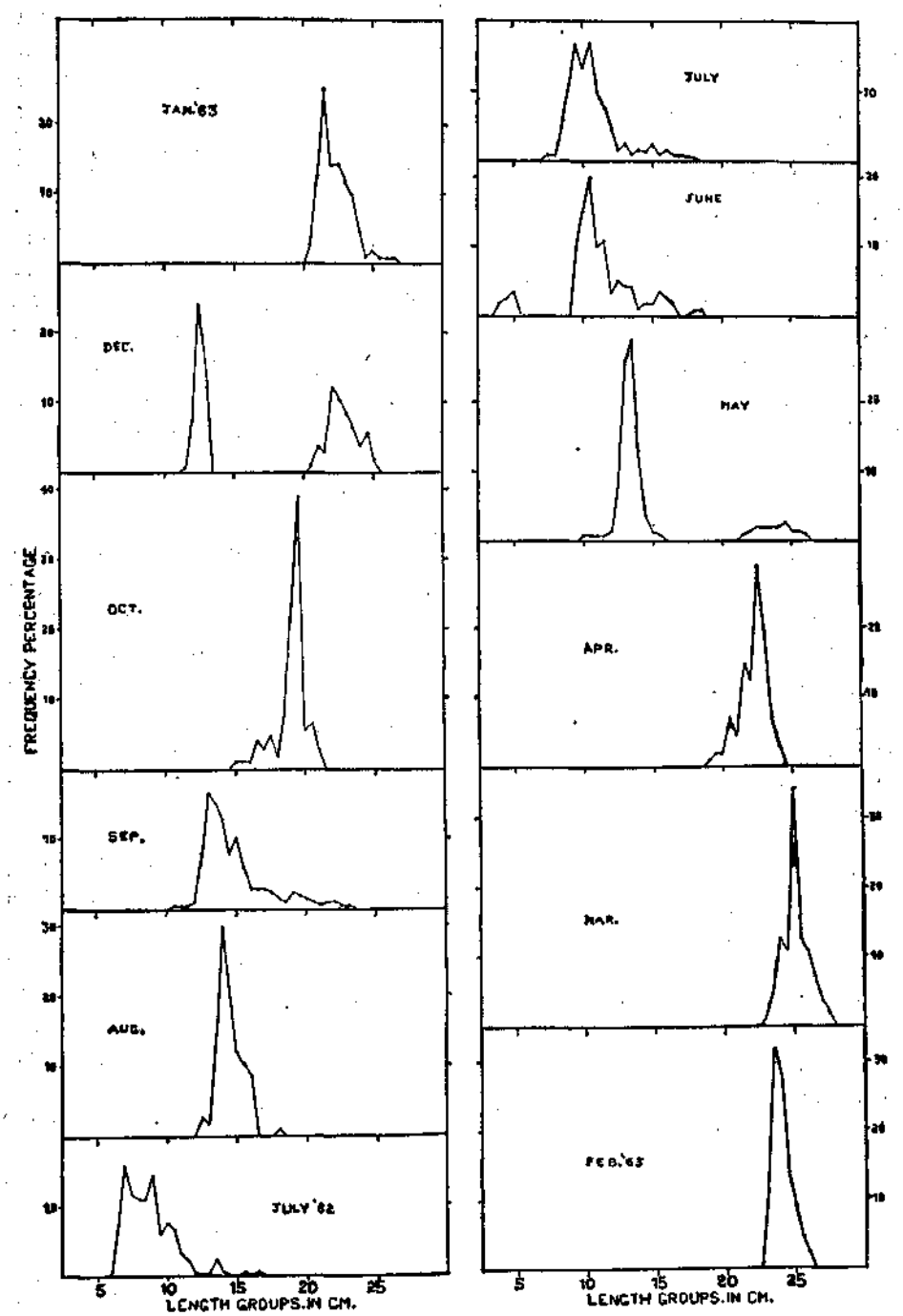

FIG. 3 Percentage length composition of the 1962-63 commercial mackerel catch at Vizhingam.

Monthly length composition of mackerel landed during the period are given in figures 1 to 3. Size group composition during the various seasons remained fairly stable with only slight differences. Major deviation during the period was the absence of mackerel from the catches in November 1962. There appears to be no uniformity in the appearance of very small size groups of mackerel. In the 1960-61 fishery small fish from 4.0 to 8.0 cm. appeared during July, November and December 1960 and May 1961. Small fish appeared in the 1961-62 season July, August and November 1961 and February and June 1962. In the 1962-63 fishing season juveniles appeared in July 1962 and June 1963. It seems as though the mackerel off Vizhingam consists of several distinct spawning stocks each with separate seasons of recruitment. Relative contribution of the various size and age groups to the commercial catch is due partly to the availability of and partly to size selectivity of the nets used by the fishermen when certain size groups are passing through the area.

Temperature Variations

Seasonal abundance and territorial distribution of fish shoals are to a very large extent regulated by environmental factors. In the absence of any physical barrier, shoals of fish at times move according to definite pattern. Knowledge of this pattern of movement within the distributional range of fish populations is necessary for understanding variations in availability, for predicting fishing seasons and for locating fishing grounds. Study of the year to year temperature changes at Karwar shows that there exists relationship between the lowest surface temperature at the inshore waters during the monsoon season and magnitude of the mackerel fishery.

Surface and atmospheric temperature recordings were made twice a day, at 900 hours and 1400 hours. Average of the two recordings are plotted in Fig. 4. The differences between daily averages of surface and atmospheric temperatures are not great during the period from November to April. From late May to early October there are wide variations in the average surface and atmospheric temperatures. During May to October average atmospheric temperatures are around or below 30°C while the surface temperature average are around 25°C. On the other hand from November to April both atmospheric and surface temperatures keep around or above 30°C. These two temperature seasons are almost constant during successive years and are largely due to the winter and summer conditions prevailing in the coast. Except for few days in the year average surface temperatures are below average atmospheric temperatures. Greatest differences between atmospheric and surface temperatures were found during monsoon and post monsoon months (June to September). During rest of the year atmospheric and surface temperatures are very close. A few days in November atmosphere temperature fell below surface tempe-

TABLE IV

Maximum and minimum temperatures recorded at Vizhingam during 1961 to 1963 ($^{o}_{C}$)

Month	1961				1962				1963			
	Surface		Atmospheric		Surface		Atmospheric		Surface		Atmospheric	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	..	..	..	..	30·0	28·0	30·5	28·0	29·25	27·5	30·5	26·5
February	..	..	..	..	30·5	27·75	31·5	28·5	30·0	27·5	31·25	27·5
March	..	..	..	..	30·5	28·25	32·5	29·0	30·5	28·5	31·5	29·0
April	..	..	..	..	31·0	28·75	33·0	27·75	31·75	29·25	33·02	29·5
May	..	..	..	..	30·75	25·5	33·0	27·0	31·5	26·5	33·5	29·0
June	27·0	24·25	30·5	25·0	28·5	24·5	31·0	27·0	25·5	24·0	31·0	26·75
July	26·0	23·5	29·5	25·5	26·25	22·5	30·0	25·0	26·0	23·5	30·5	27·0
August	26·0	23·0	29·5	26·5	27·5	22·75	30·5	26·0	..	..	..	..
September	28·0	24·0	30·0	27·0	26·5	23·5	30·75	26·0	..	..	..	..
October	29·00	26·0	30·5	28·0	29·0	25·0	31·0	25·75	..	..	..	..
November	30·5	25·5	31·5	26·0	30·0	27·0	31·0	27·0	..	..	..	..
December	29·75	28·25	30·5	28·0	30·0	28·0	31·0	28·25	..	..	..	..

rature. Monthly maximum and minimum temperatures recorded during the period are tabulated in Table 4. It is seen that the surface temperature reached the lowest during the monsoon months. Highest surface temperature was recorded in April. The lowest atmospheric temperature was attained in June while the highest was recorded in April and May.

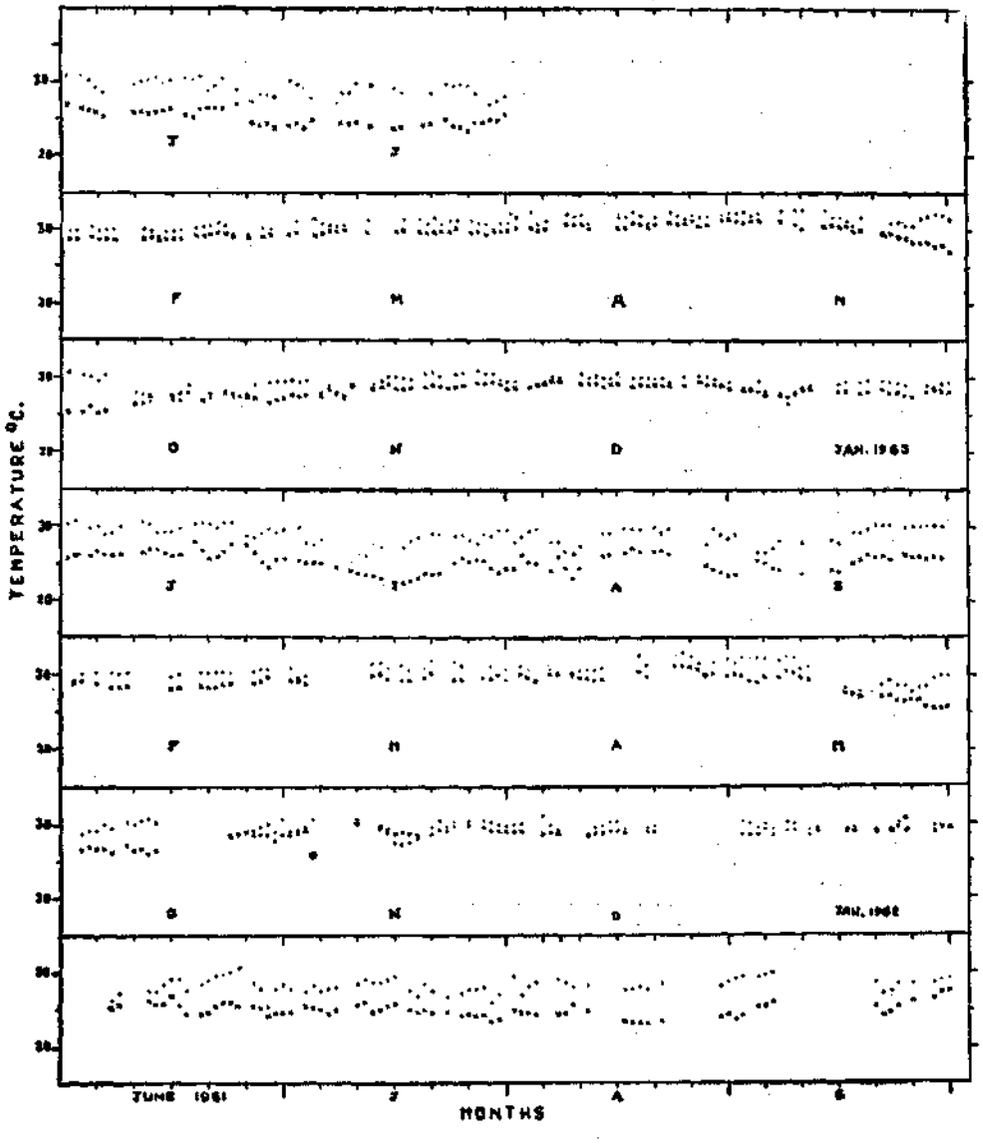

FIG. 4 Daily average surface and atmospheric temperature distbution at Vizhingam during 1961-1963 (dots denote atmospheric temperature, crosses denote surface temperature)

Considering the catch of mackerel in different months it is evident that no definite correlation as such exists between the mackerel fishery at Vizhingam and the variations in surface or atmospheric temperatures. However, during June and July small sized mackerel were caught in large numbers two or three days after light rains and fall in surface temperature. Small mackerel was never recorded during the course of this study when the temperature was very low. Young mackerel appeared in the fishery in February despite high temperatures. Large sized mackerel are caught depending mostly on the selection of gear by fishermen and availability of shoals at the fishing area rather than on temperature changes.

Discussion

The Indian mackerel supports a minor fishery at Vizhingam. Three age groups were observed to enter into the fishery, 0-year group, 1-year group and 2-year group. Most interesting feature of the 1960-63 seasons was the dominant role of the small sized juvenile mackerel represented by the 0-year group. This group has been responsible for a good portion of the number of fish landed. In terms of weight of mackerel landed at Vizhingam the position looks entirely different. Considering 1960-61 as the base year it is seen that the mackerel landed during the season amounts to 44,379 kg. with total landings of 8,57,346 fish. During the next season only 18,277 kg. of fish were landed with 17,25,818 individuals. Similarly in 1962-63 the catch composed of 20,416 kg. with 24,58,963 mackerel. In July 1963 also 27,79,577 fish accounted for only 38,167 kg. The better weightage of fish during 1960-61 was due to more (by number) of larger fish in 1-year and 2-year groups than the 0-year juveniles. During the subsequent seasons the fishery was supported by large number of juveniles with much less weight.

Another feature of the Vizhingam fishery is the appearance of young juveniles. The appearance of very young fish gives a fairly good prediction of the spawning season of the mackerel. Balakrishnan (1957) has shown that young juveniles occur at Vizhingam during March to August with the smallest groups occurring in April, May and June. He has also stated that plankton hauls collected on 23rd May 1956 contained pro-larvae of 2.8 mm. and hauls made during March to May contained unconfirmed planktonic mackerel eggs. During the present study very young mackerel were caught in the commercial nets several times. In July 1960 the smallest group was 6.0 cm. long. In November 1960 smallest mackerel measured 4.5 cm. and in December 1960, 5.0 cm. During 1961 smallest mackerel obtained was 4.0 cm. in July and 3.5 cm. in November. The smallest group in 1962 was in 4.0 cm. and occurred in February and June. During June 1963 mackerel as small as 4.0. cm. occurred in the catches. Sekharan (1958) states that in the south Canara coast mackerel

starts spawning in March or April though the highest spawning might occur sometime later. Studies made by Pradhan (1956) and Devanesan and Chidambaram (1948) show that the breeding season of the Indian mackerel is from June to September. However Chidambaram *et al.* (1952) attribute a still prolonged spawning period for the mackerel, from April to September. From the Madras coast Rao and Basheeruddin (1953) and Basheeruddin and Nayar (1961) recorded the occurrence of young mackerel during March and April months. They infer that the species breeds during or after the north-east monsoon on the east coast. The situation at Vizhingam looks quite different. It has to be safely presumed that either (1) the mackerel has two main spawning seasons, one between March and May, and the other between August and September with a subsequent minor spawning in December or January or (2) the mackerel population around Vizhingam consists of a mixture of West coast and East coast spawning stocks each spawning at different times. Spawners of the west coast may be responsible for the juvenile fishery during May, June, July, November and December and that of the east coast may be responsible for the young fish appearing in February. After all, Vizhingam is quite close to the area of admixture of the water masses of the two coasts. Regular appearance, at various seasons of the year, of very young mackerel suggests that there exists a mackerel spawning ground not far off from Vizhingam coast.

Certain amount of accurate prediction was made at Karwar about the mackerel fishery based on the minimum surface temperature of the monsoon months. It has been observed that lower the inshore surface temperature the longer is the mackerel fishery for the season. Temperature observations conducted at Vizhingam during 1961-63 show no definite correlation between the surface or atmospheric temperature and the occurrence and intensity of the mackerel fishery, although the indications are that young juveniles occur after light rains.

Summary

A brief account of the fishery for small sized juvenile mackerel at Vizhingam is given. The mackerel fishery is supported mainly by the 0-year group juveniles. Landings by commercial units fluctuated year to year. July was the best month for the mackerel fishery and the catch during this month, at times, exceeded the average monthly landings by even ten times.

Length and age group composition of the commercial catch are analysed. Mackerel from 3.5 cm. to 28.0 cm. occurred in the landings. They belonged to 0-year to 2-year groups. The 0-year group dominated the number of fish landed. Very small sized mackerel occurred during June, July, November, December and February. It is suggested that either the mackerel has two

main spawning seasons, in March to May and August to September, with a subsequent minor spawning in December to January or the mackerel population off Vizhingam consists of a mixture of east coast and west coast spawning populations.

Variations in the surface and atmospheric temperature during 1961 to 1963 are described. There seems to be no direct correlation between the surface or atmospheric temperature and the duration and intensity of the mackerel fishery although small sized mackerel enter into the fishery after light rains.

ACKNOWLEDGEMENT

The author expresses his grateful thanks to Dr. S. Jones, Director, Central Marine Fisheries Research Institute, for his guidance and valuable help during the course of this work, and to Dr. G. Seshappa, Research Officer for going through the manuscript and offering helpful criticisms.

REFERENCES

Anon 1963 . . . . . Annual Report of the Director, Central Marine Fisheries Research Institute for the year ending 31st March, 1963.

——— 1964 . . . . . Annual Report of the Director, Central Marine Fisheries Research Institute for the year ending 31st March 1964.

Basheeruddin, S. and Nayar, K. Nagappan 1961. A Preliminary Study of the Juvenile Fishes of the Coastal Waters off Madras City. *Indian J. Fish.* 8 (1) 169—188.

Balakrishnan, Vylopilli 1957 . . . Occurrence of Larvae and Young Mackeral (*Rastrelliger canagurta* Cuvier) off Vizhingam near Trivandrum. *Curr. Sci.*, 26, 57-58.

Chidambaram, K., Krishnamurty, C. G., Venkataraman, R. and Chari S. T. 1952. Studies on Mackerel Fat Variations and Certain Biological Aspects. *Proc. Indian Acad. Sci.* 35, 43—68.

Devanesan, D. W., and Chidambaram, K. 1948. The Common Food Fishes of the Madras Presidency, *Govt. Press, Madras.*

Jones, S. and Silas, E. G. 1962 . . A Systematic Review of the Scombroid Fishes of India. *Marine Biol. Asso. India.* Symposium on Scombroid Fishes, 1, 1—106.

Nayar, S. Gopalan 1958 . . . . A Preliminary Account of the Fisheries of Vizhingam. *Indian J. Fish.* 5 (1) 32—55.

42—1 DCM/FRI/67

Rao, K. Virabhadra 1962 . . . Distribution of the Young Stages of the Mackerel, *Rastrelliger kanagurta* (Cuvier) in the Indian Inshore Waters. *Marine Biological Association of India.* Symposium on Scombroid Fishes, 1, 469—482.

Rao, K. V. and Basheeruddin, S. 1953 . Occurrence of Young Mackerel, *Rastrelliger canagurta* (Cuvier), off Madras Coast. *Curr. Sci.*, **22**, 182-83.

Sekharan, K. V. 1958 . . . . On the South Kanara Coastal Fishery for Mackerel, *Rastrelliger canagurta* (Cuvier) together with Notes on the Biology of the Fish. *Indian J. Fish.* **5** (1), 1—31.

Panikkar, N. K. 1952 . . . . Fisheries Research in India. Part I, *Jour. Bombay Nat. Hist. Soc.*, **50**, 741—65.

Pradhan, L. B. 1956 . . . . Mackerel Fishery of Karwar. *Indian J. Fish.*, **3** (1), 141—85.